

CLAIMS

What is claimed is:

1. A method of making a photoelectrode comprising a semiconductor layer having a surface in contact with a transparent electrically conductive metal oxide (TCO) layer, said method comprising:

generating a flux of material by bombarding a target comprising indium oxide and tin oxide for a time of at least 30 minutes at a temperature of at least 200°C in a non-oxidizing atmosphere; and

collecting said material on said surface of said semiconductor layer to form said TCO layer thereon which comprises indium tin oxide.
2. The method of claim 1 wherein said generating a flux of material by bombarding a target is conducted by sputter deposition.
3. The method of claim 1 wherein said non-oxidizing atmosphere is an inert atmosphere.
4. The method of claim 2 wherein said non-oxidizing atmosphere comprises argon.
5. The method of claim 2 wherein said non-oxidizing atmosphere is essentially oxygen-free.

6. The method of claim 1 wherein said temperature is at least 230°C.

7. The method of claim 1 wherein said time is at least 60 minutes.

8. The method of claim 1 wherein on the basis of 100 parts by weight, the indium oxide constitutes 90 parts and the tin oxide constitutes the balance.

9. The method of claim 1 wherein the TCO layer comprises predominately a cubic-phase oxide and a smaller amount by weight of a hexagonal-phase oxide.

10. The method of claim 1 wherein the TCO layer comprises a highly oriented film of highly oriented crystals.

11. The method of claim 1 wherein the indium oxide is represented by In_2O_3 and the tin oxide is represented by SnO_2 .

12. A method of making a photoelectrode comprising a semiconductor layer having a surface in contact with a transparent electrically conductive metal oxide (TCO) layer, said method comprising:

bombarding a target comprising indium oxide and tin oxide (ITO), where on the basis of 100 parts by weight of the target the indium oxide constitutes 90 parts, in a non-oxidizing atmosphere for a time and at a temperature sufficient to deposit said layer of TCO comprising said ITO at a thickness greater than 3000 Angstroms.

13. The method of claim 12 wherein said thickness is greater than 4000 Angstroms and the target consists essentially of 90 parts indium oxide and ten parts tin oxide by weight.

14. A photoelectrode comprising a semiconductor layer having first and second opposite major surfaces, said first major surface overlaid with a layer of indium tin oxide (ITO) having a thickness of at least 4000 Angstroms.

15. The photoelectrode of claim 14 wherein said semiconductor layer comprises photovoltaic, amorphous, silicon n-i-p material; and said indium tin oxide layer overlies p of said n-i-p.

16. The photoelectrode of claim 14 wherein said semiconductor layer second major surface is in contact with an electrically conductive substrate.

17. The photoelectrode of claim 16 wherein said photoelectrode comprises in order: said electrically conductive substrate comprising ss/Ag/ZnO, and said semiconductor comprising n-i-p; wherein said n-layer faces said ZnO, and said ITO layer overlies said p-layer.

18. A photoelectrode comprising a semiconductor layer having a surface overlaid with an indium tin oxide (ITO) layer in the form of a highly oriented film.

19. A photoelectrode comprising a semiconductor layer having a surface overlaid with an indium tin oxide (ITO) layer which comprises predominantly a cubic-phase oxide and a smaller amount by weight of a hexagonal-phase oxide.

20. A photoelectrochemical device for electrolysis of water to produce hydrogen comprising:

a container housing a photoelectrode, a counter electrode and an electrolyte solution, said photoelectrode and said counter electrode spaced apart from one another in said container and each being in contact with said electrolyte solution;

a photoelectrode comprising:

a semiconductor layer having a first major surface coated with an indium tin oxide (ITO) layer having a thickness of greater than 3000 Angstroms; and a second major surface in contact with an electrically conductive substrate;

said counter electrode comprising a metal;

said solution comprising a solvent which comprises water and a solute which comprises a base; and

an electrically conductive path external to the solution between said photoelectrode and said counter electrode.

21. The device of claim 20 wherein said indium tin oxide layer is formed by generating a flux of material by bombarding a target comprising indium oxide and tin oxide and collecting said material on said first major surface of said semiconductor layer.

22. The device of claim 20 wherein said photoelectrode comprises in order: said electrically conductive substrate comprising ss/Ag/ZnO, and said semiconductor comprising n-i-p; wherein said n-layer faces said ZnO, and said ITO layer overlies said p-layer.

23. A photoelectrochemical device for electrolysis of water to produce hydrogen comprising:

a container housing a photoelectrode, a counter electrode and an electrolyte solution, said photoelectrode and said counter electrode spaced apart from one another in said container and each being in contact with said electrolyte solution;

a photoelectrode comprising:

a semiconductor layer having a major surface coated with an indium tin oxide (ITO) layer in the form of a highly oriented film.

24. The device of claim 23 wherein said ITO layer comprises predominantly a cubic-phase oxide and a smaller amount by weight of a hexagonal-phase oxide.